

CHAPTER 5

Criterion IV: Social and Economic Indicators of Rangeland Sustainability

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Abstract: Social and economic systems provide the context and rationale for rangeland management. Sustaining rangeland ecosystems requires attention to the social and economic conditions that accompany the functioning of those systems. We present and discuss economic and social indicators for rangeland sustainability. A brief conceptual basis for each indicator is offered, describing its potential relationship to rangelands.

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Introduction

Healthy rangeland ecosystems depend on supportive social and economic infrastructures. Social and economic infrastructures provide the framework or context in which rangeland use occurs and rangeland health improves or deteriorates. To look at rangeland sustainability exclusive of that social and economic infrastructure is to see an incomplete picture.

The economic and social literature on conservation values and behavior consistently indicates that farmers may have strong stewardship values, but those values are not always reflected in actual conservation behavior. This “disconnect” between beliefs and values on the one hand and actual behavior on the other is often evident when markets mediate management decisions (Coughenour and Swanson 1994). This association has a long history in the socioeconomic conservation literature. Heady and Allen (1951) determined that Iowa farmers who practiced conservation appeared to act irrationally when their behavior was evaluated strictly relative to market demands. Indeed, conservation policy since the New Deal has sought to narrow the gap between what farmers would like to do and what they can put into practice given market realities and incentives (Coughenour and Swanson 1994).

While this literature has focused on farming, the basic principles are relevant for ranchers and rangeland management. Implementing sustainable practices in the context of competitive markets can be difficult. Like farmers, ranchers are expected to internalize the costs of conservation. And, like farmers, ranchers have often chosen economic viability over their desire for more sustainable systems. Sustainable rangeland management, whether on public or private lands, will be influenced by the values of key stakeholders and by the political economy and market structures in which management decisions are made. It is important that such factors be measured and applied to empirical assessments of rangeland sustainability.

The relevance of social and economic factors to sustainable ecosystems was pointedly illustrated by Vosti (1993) when describing survival in the Brazilian Amazon:

Jose (Carvalho) doesn't have a perverse desire to denude the world of rain forests, nor does he love the toil, danger, or high cost associated with felling massive trees with fairly rudimentary tools. Jose wants to guarantee food on the table and a livelihood for his family of six living in one of the least hospitable places in the world. It is not an easy task. Jose has been dealt a bad hand in the social reshuffling of natural resources. But by hook or by crook, he gained access to trees (lots of them), poor soils, seasonally torrential rains, malaria (lots of it), and isolation—all of which combine all too frequently to generate hunger.

Jose is not completely ignorant about the valuable hardwoods or rich biodiversity contained in the remaining forested portion of his lot that persuades him to pick up his saw. No, he has heard that his private forest contains strange and potentially useful trees and plants. But he is a newcomer to the area, and there is no one to tell him which plants are possibly valuable, and virtually no scope for turning these trees or special plants into cash or food, which is what his patch of forest must generate in order to sustain his family.

Jose is not shortsighted either. He does look to the future. He knows his annual cropping patterns will deplete soil nutrients. But his view of the future is through the window of the present – action taken today may bring doom tomorrow, but failure to undertake today's action will almost certainly bring today's doom.

Jose knows that some agricultural strategies require much less forest conversion than others. He knows that horticultural pursuits require the least amount of cleared land, and cattle require about one hectare of cleared forest per head. But poor market links, virtually nonexistent banking systems, and ever-increasing shortages of agricultural labor (including on-farm labor as Jose's family grows older and off-farm wage labor as urbanization trends accelerate in these hinterland areas) force his hand. He must diversify his production activities in ways that reduce risk and can be done with available labor – the trend towards increased cattle production is clear and rational. (Vosti, p. 24)

The story is from Brazil, but the dilemma is repeated in many parts of the developing world. The principles underlying Jose's situation are relevant here.

“Given his ecosystem, his aspirations, and the constraints he faces, Jose has no choice but to deforest small plots of his land. It is legal to do so on up to 50 percent of his land. Once the land is exhausted—often after a few years—he needs to deforest more. His choices are limited; his future is bleak. He begins to saw the next tree.” (Vosti 1993, p. 25).

The Roundtable on Sustainable Forests acknowledged the necessity of social and economic indicators (USDA Forest Service 2004), but the group focused primarily on ways in which the natural resource base benefits the economy and society. We attempt to take that a step further and give equal weight to the reciprocal relationship: the potential positive and negative impacts of the economy and society on the sustainability of natural resources, and rangelands in particular (Azar et al. 1996). Not only do natural resources contribute to economic and social well-being, but economic and social infrastructure and conditions contribute to (or detract from) ecosystem condition and sustainability.

It is difficult to define economic and social indicators that directly relate rangelands and rangeland conditions to social and economic dynamics. Social and economic structure is bigger than rangelands. Rangelands (and other natural resources) play different roles in different places. In some areas, rangeland and its uses are major components of local society and economies. In other areas, rangeland plays virtually no role at all. Because of those different levels of involvement in local social and economic systems, the indicators we consider relate to communities rather than specifically to rangelands. Depending on the locality, rangelands and rangeland use are just one of multiple natural resource-based land uses. Rangelands are not unique in their dependence or their influence on social and economic infrastructure. Timber and mining, for example, have similar interplay with communities. This points out one of the differences between the social and economic indicators and the more ecological-oriented indicators that are detailed in other chapters of this monograph. The ecological-oriented indicators focus directly on the land and on rather specific plots or groups of plots. The social and economic indicators focus directly on communities and people that affect and are affected by the land and only indirectly focus on the land itself. That is not to say that one set of indicators is more important than the other, just that they are different and the two sets complement one another.

Underlying this discussion of social and economic indicators of rangeland sustainability is the notion that there is a reciprocal relationship between social, economic, and ecological well-being. That is a fairly standard interpretation of sustainability. But, how does this relationship work? And how do actions or conditions or disturbances in one realm (i.e., social, economic, or ecological) affect conditions in other realms? The key question is: What linkages exist between (and within) social, economic, and ecological components of the big picture of rangeland ecosystems and how do they affect sustainability? The Sustainable Rangelands Roundtable (SRR) has proposed a conceptual framework in which to think about such linkages and effects (Fox et al.

2009), and some illustrative applications of the framework can be found in Maczko and Hidinger (2008). That framework suggests pathways along which to look for linkages among the social, economic, and ecological realms of rangeland ecosystems, and explore potential interactions. The example of Jose Carvalho and the Brazilian rainforest cited earlier fits within this framework. That example suggests the ecological well-being is a function of economic and social well-being. A hypothesis then would be that we expect to see an increase in sustainable rangeland management practices as ranchers' social and economic well-being improves. There is also likely to be a relationship in the other direction, i.e., positive and negative effects of the resource base on the economy and on society. As rangeland condition or health improves or deteriorates, we expect to see human and community well-being also improve or deteriorate. Further, we expect to see individual components of social, economic, and ecological well-being react as they are influenced by changes in other components.

Directly measuring economic and social indicators at the national or even regional levels of analyses presents an array of conceptual and methodological challenges when the objective is to provide unambiguous empirical associations with other indicators and conditions of rangeland health. These challenges include 1) establishing the relationship of economic and social factors to rangeland sustainability, 2) determining causal relationships among socioeconomic and ecological indicators, 3) addressing issues associated with the unit of analysis (scale), and 4) finding and obtaining data for the indicators.

Several of the socioeconomic indicators described here are indirect measures that include economic and social structures generally associated with individual and community well-being. For example, measures of demographic structure provide indirect indicators of population stability, distribution of populations by age, gender, ethnicity, social stratification, and rates of change that can be assumed to indirectly measure components of actual well-being of individuals and their communities. The conceptual and methodological challenge is to tease out the degree of association among these indicators that can reasonably be attributed to the relationship between rangeland health and human activity.

Even in sub-regions of the United States that are predominantly characterized by rangeland ecosystems, the economic and social activities occurring within landscapes may have limited direct impacts on rangeland ecology. A rural community may gain population due to natural amenities that attract retirees while the number of people in direct production activity on rangeland declines. Or, as rural communities diversify their economic base, they may provide off-ranch employment opportunities that make it easier for otherwise economically marginal ranching operations to stay in business. We address this lack of direct measures by providing a minimum number of indicators that cover basic conceptual issues associated with economic and social activity. This provides a basic dataset useful for examining the associations between socioeconomic activity and rangeland sustainability.

The Problem of Scale

The issue of scale presents a persistent challenge when defining and using social and economic indicators. Economic and social conditions within any county, state, or region are potentially very diverse. This is especially true as the scale of analysis moves from the local or specific area to a regional or national level. Changes in local areas can be masked by conditions across a larger area.

It is our contention that social and economic indicators are most meaningful at a local scale. Ideally, we would like to have the ability to measure indicators at a community level. Higher levels of aggregation can mask effects and impacts that are important to communities. In cases

where an aggregated perspective is desired, communities can be combined to provide such higher levels of aggregation. Pragmatically, however, counties seem to be the closest approximation possible to communities with a reasonable degree of consistency of available data. Social and economic data are generally reported at the county level. In most cases, the actual sampling is at a finer level, such as the individual, family, or household. In some cases, opportunities exist for spatial and temporal analyses below the county level, but such data are spotty at best and often incomplete in terms of the number of years for which data have been collected. Sample sizes in a county-wide sample are often not large enough to permit rigorous analyses of sub-county areas.

Generally, data related to rangeland uses and user behaviors are sparse and often not collected in a way that allows one to distinguish across vegetative types. Recreational use of rangelands is one example. Data are available for some specific areas but not others and for some specific activities but not others. Even when data are collected on the same activities, the definition of variables may not be consistent enough to be combined across geographic areas and over time. Even grazing data are incomplete and inconsistent. Data are collected on the number of animal unit months (AUMs¹) available in particular grazing allotments but often not on the number of animals actually grazing the allotment.

While only a very imperfect representation of a community, the county level is the spatial scale most likely to provide consistent data across multiple areas. In an ideal world, we would be able to aggregate indicator data up to regional and national scales. As noted by Haynes (2003, p.2), however, little guidance is available for how to scale community information upward to broader spatial scales. Interpretation of community-oriented indicators becomes more difficult, and probably less meaningful, as scale broadens to regional or national levels.

Social and Economic Indicators of Sustainability

We have chosen three groups of indicators in our attempt to capture the interplay between social and economic structures and processes and rangeland sustainability. “National Economic Benefits” considers the types of products coming from rangelands that are valued by society. This is one aspect of the ways in which rangelands affect people and vice-versa. “Community Well-Being and Capacity” seeks to describe how communities are faring in rangeland-dominated areas.

The indicator set, “Community-Level Explanatory Indicators that might be Relevant to Sustainability,” seeks to understand how communities affect rangelands. Each indicator is discussed within its grouping. “Data sufficiency” for each indicator is classified as A, B, C, and/or D depending on whether methods and procedures for data collection and reporting are sufficient and whether datasets of a useable quality exist at an appropriate scale. The data sufficiency categories are shown in Appendix 1-E.

National Economic Benefits

Indicators titled “National Economic Benefits” relate to the products and benefits derived directly from rangelands and rangeland use. The indicator numbers refer to the overall list of rangeland indicators developed by the Sustainable Rangelands Roundtable (SRR). The complete list of criteria and indicators can be found in Appendix 1-C.

¹ An animal unit month (AUM) is defined as the amount of forage required by one animal unit (defined as a 1,000 pound cow, or the equivalent) for one month or the tenure of one AU for a one-month period.

Indicator 27. The value of forage harvested from rangeland by livestock.

Livestock grazing is the historical economic use of rangelands and continues to be an important use on both public and private lands. Changes in the value of forage used by grazing animals can indicate change in rangeland sustainability because they suggest increased (or decreased) pressure to harvest vegetation as forage to the exclusion or detriment of other uses or values. Forage values can also indicate quality of the forage in a particular area.

Indicator 28. Value of non-livestock products from rangeland.

This indicator relates to the economic value of products from rangeland that are not related to livestock production, including recreation, wildlife and wildlife habitat, scenic views, nature experiences, open space, etc. Rangelands produce more than just livestock. The value of these other outputs is important for recognizing the full range of contributions made by rangeland and the land-use pressures that might affect sustainability.

Indicator 29. Number of visitor days by activity and recreational land class.

This is a measure of the quantity of recreation use on rangelands and where it occurs. It has relevance to sustainability as a measure of benefits derived from recreation on rangelands and intensity of use. Different types of recreation affect land differently in relation to rangeland health and sustainability. Classifying recreational land as primitive areas, roadless areas, open public lands, private lands, or other types provides a basis to compare the intensities of recreation use across rangelands and how use changes through time.

Indicator 30. Reported threats to quality of recreation experiences.

This indicator is envisioned as a way to address a problem inherent in simple measures of recreation use: rangeland sustainability is influenced by the ecological and social impacts of recreation use, and these impacts are not necessarily correlated with user density.

Biophysical impacts of recreation typically follow a curvilinear pattern where marginal changes in impacts (e.g., soil compaction, change in plant species composition) become smaller as use levels increase. As a result, changes in visitor numbers may or may not indicate loss of additional value at the site level, depending on whether use is already low, moderate, or high. Social impacts of recreation – crowding, conflict between user groups, and depreciative behaviors (vandalism, littering, rule violation, etc.) – are more dependent on characteristics of the use and users than on simple numbers of users.

Accordingly, a useful indicator of recreation value, and the relationship of recreation activity to sustainability, should account for quality as well as quantity. One way to do this might be to create a composite index based on manager reports from a scientific sample of rangeland recreation settings, stratified by the number of discrete units and the spatial extent of land ownerships.

Questions used in this index could include

1. “How would you characterize the level of crowding complaints by recreationists in your jurisdiction during the past year: significantly decreased, slightly decreased, same, slightly increased, or significantly increased?”
2. “How would you characterize the level of conflicts between recreation uses or user groups in your jurisdiction during the past year: significantly decreased, slightly decreased, same, slightly increased, or significantly increased?”

3. “How would you characterize the level of depreciative behaviors (vandalism, littering, rule violations, etc.) in your jurisdiction during the past year: significantly decreased, slightly decreased, same, slightly increased, or significantly increased?”

Along with this (qualitative) index, quantitative data related to physical features such as road density, trails, home density, and so on, would need to be collected and linked to the index.

Indicator 31. Value of investment in rangeland, rangeland improvements, and recreation/tourism infrastructure.

This indicator relates to expenditures on new structures and similar inputs for a variety of uses. It is the amount agencies and individuals are willing to spend on infrastructure for any given use of rangelands. It would be useful if data could be found that differentiate between public investment, private investment, and cost-sharing (joint investment). In terms of sustainability, it should indicate how much the current generation is willing to invest to maintain and improve the resource base for a variety of uses. Investment explicitly implies that funds are expended to obtain (or enhance) future returns from productive rangeland uses by expanding or enhancing natural capital (the natural resource base).

Indicator 32. Rate of return on investment for range livestock enterprises.

This indicates whether ranch families are earning a competitive rate of return from producing livestock on rangelands. If the rate of return on rangeland-based livestock operations is not competitive, it might indicate that other on-ranch forms of economic returns and/or lifestyle values are important (Torell et al. 2001), other off-ranch sources of income are important, or that the ranch is likely to be converted to other uses. The latter may pose threats to biological diversity of ecosystem processes (e.g., oil/gas development, rural subdivision).

Indicator 33. Area of rangelands under conservation ownership or control by conservation organizations.

This indicator measures the number of conservation easements and number of acres protected under conservation easement. It shows the presence and trend of open space or other undeveloped or minimally developed land areas. It is an amenity availability measure and speaks to the desirability, adaptability, and resilience of communities, and to the community perception of the importance and value of that land use or asset. (Wiebe 1995; Wiebe et al. 1999)

Indicator 34. Expenditures (monetary and in-kind) for restoration activities.

The amounts of funds and in-kind contributions, like time volunteered, that organizations and individuals contribute to rangeland restoration activities indicate the strength of importance that people place on restoring and maintaining rangelands. These expenditures are made to maintain, enhance, or restore the rangeland ecosystem without explicit future monetary returns necessarily expected from the investment.

Indicator 35. The threat or pressure on the integrity of cultural and spiritual resource values.

This indicator relates to the intensity of concern over, and pressures for management of, cultural and spiritual resources, which are assets valued by particular groups of people (Eisenhauer et al. 2000). It is assumed that when spiritual or cultural values are threatened by activities on rangelands, citizens will suffer loss of value from those rangeland uses and may act to protect those values in ways that might decrease the value of other resources (e.g., by restricting livestock grazing or recreation access—either by legislation or regulation).

This indicator could be a two-part, subjective measure of increase/decrease in concern over potential threats or pressures placed on spiritual and cultural resources. The best way to do this might be via two direct questions on an annual survey (census or random sample) of field-level managers of public rangelands. While it is likely important on private lands, those data are not likely to be known, available, or acknowledged. Question items might include

1. “How would you characterize the level of public concern expressed during the past year over the status of spiritual resources (e.g., religiously important sites, citizens’ ability to obtain desired contemplative benefits from rangelands) in your jurisdiction: significantly decreased, slightly decreased, same, slightly increased, or significantly increased?”
2. “What is your perception of the occurrence of incidents during the past year that compromised the integrity of historic or archaeological sites within your jurisdiction: significantly decreased, slightly decreased, same, slightly increased, or significantly increased?”

Community Well-Being and Capacity

Indicators of “Community Well-Being and Capacity” are intended to portray local social and economic structure and capacity. According to rural sociological theory, the theoretically appropriate unit is a community, or at least a relatively local unit of social organization (Wilkinson 1991). While there is a wealth of social and economic data that can inform inquiries about well-being, most of the relevant data are only available at the county level. Only infrequently, and in limited areas, are such data collected at the smaller community scale. As stated above in the section on “Scale,” we are left to assume that the county is a “reasonable” or “best available” approximation to the community unit.

Which characteristics describe the “community” as a whole and the interactions and relationships between individuals within the community? That has been, and continues to be, an active topic of research. Our hypothesis is that consideration of certain key characteristics and tracking them over time is indicative of the resilience of a social system and its capacity to weather and adapt to changing resource conditions. These characteristics and their interpretation may be only indirectly tied to rangeland, but the health and resilience of the local social and economic structure is very likely to play a role in the sustainability of rangeland and rangeland use.

Indicator 36. Poverty rate – general.

The U.S. Department of Agriculture (USDA), in cooperation with other federal agencies, sets the poverty rate at the level where one-third or more of the household budget is spent on food. It is assumed that any household spending one-third of its budget on food is unlikely to be maintained at a minimal quality of life. This general poverty rate is a gross measure of social stratification that indicates the extent of poverty within a county or local area (U.S. Census Bureau 2000). The greater the concentration of poverty (e.g., a higher percentage of a given population in poverty) the less likely it is that the population has the resources necessary to adapt to ecological and socioeconomic changes (Newman 2002: Chapter 10). Such increased social stratification, then, is related to a reduced ability to sustain counties. A lower capacity to adapt to changes implies a lower level of sustainability. This indicator is needed to interpret interaction effects with other indicators.

Indicator 37. Poverty rate – children.

This indicator adds to the previous one by measuring the proportion of children (age 17 or younger) who live in households determined to be at or below the poverty threshold. Children in poverty can be a more specific indicator of community resilience because it may portend future capacity. Communities with high rates of poverty appear to have a legacy of poverty over time (O'Hare and Johnson 2004). A higher rate is associated with lower integration into the community and a higher likelihood of undesirable outcomes like reduced health status, human capital, and social capital. This indicator is needed to interpret interaction effects with other indicators.

Indicator 38. Income inequality.

This indicator addresses economic distribution and speaks to social equity. It indicates the general welfare of the community by looking at the distribution of people across a range of incomes and measuring the income disparity in the community. It is a direct measure of economic and social stratification that complements poverty statistics. Lower levels of income inequality are associated with higher cohesion or integration of the community, leading to a more stable and resilient community. This indicator permits more sensitive measurement of social and economic inequality when a Gini coefficient is applied. A Gini coefficient is a widely used rough measure of the amount of inequality in the income distribution (Eckert and Garner 2003). Gini coefficients measure the divergence between the income distribution actually occurring in a given geographic area (as portrayed by the Lorenz curve) and a totally equal distribution of income.

Indicator 39. Index of social structure quality.

As noted above, at the county level there are extensive data on social and economic conditions. Social science literature often addresses the multidimensionality of concepts being measured using indexes, i.e., the adding together of multiple indicators to create a single broad-based measure complying with standard statistical rules of internal reliability and validity of measurement. Since it is not possible to predict which particular variable(s) might provide the best measure of quality of local social structure for any given inquiry on sustainability, we suggest that combining several relevant variables into indexes provides a better, and more generally useable, indicator. The quality of social structure might include such things as access to and quality of medical care (e.g., per-capita hospital beds, numbers of physicians and nurses), the presence and extent of cultural and community services, the extent and availability of public recreational facilities (expenditures per capita on parks, etc.), and crime rates, among other things (Marans and Mohai 1991; Fureseth and Walcott 1990). Indexes of this type are frequently constructed to rate quality of life or desirability of living in different places, e.g., *Money* magazine's "Best Places to Retire" (www.money.cnn.com/best/bpretire/), and periodically featured in the magazine). However, there is little basis in social theory for most such indexes. Given that decisions about specific variables to include, units of measure, and weighting can strongly influence the values and sensitivity of such an index, we suggest use of this indicator should come only after considerable research and model testing. We remain convinced of its relevance but recognize its need for research and development.

An alternative to the Index of Social Structure Quality discussed above might be a measure of community resilience. Such a measure has been proposed and developed by the Roundtable on Sustainable Forestry (see the various links related to "Indicator 38: Resilience of Forest-Dependent Communities" (from September 6, 2007 meeting) found on <http://www.sustainableforests.net/summary20062007.php>, and Magis 2010). While developed in the context of forest-dependent communities this indicator is equally relevant to rangeland-dependent communities. The indicator is intended to measure the ability of communities to adapt to changing

conditions. The premise behind the indicator is that all communities have access to numerous kinds of resources, otherwise known as capitals. These include: natural, human, cultural, financial, built, social, and political capitals. A resilient community actively develops and utilizes all of its capitals, includes all segments of the community in community endeavors, engages groups to work together, works strategically toward development of the community, and works to ensure equity across community members. As the community invests in and develops its various capitals, it develops capacity to respond effectively to change, i.e., it develops Community Resilience (USDA Forest Service 2010, p. 2-96). The same capitals that allow a community to react and adapt to changing conditions allow the community to behave proactively to avoid or mitigate potentially disruptive changes. Both the capacities to adapt to change and to behave proactively before change occurs are characteristics of a sustainable community. Sustainable communities have implications for the sustainability of rangelands. The extent to which these various capitals are present in a given community can be assessed using qualitative research methods like interviews and/or surveys, and expressed in terms of an index or a set of scores based on the individual capitals. Such a measure could then be assessed and monitored over time. Research is needed to develop a measurable expression of community resilience from this conceptual construct.

Indicator 40. Community satisfaction.

This indicator describes the level of satisfaction a community or county has with socioeconomic infrastructures, employment opportunities, and social support networks (Goudy 1990; Brown 1993; Marans and Mohai 1991; Wilkinson 1991; Bender 1978). Places with low satisfaction risk significant out-migration and having low capacity for adapting to opportunities and threats. The indicator measures how the local community feels about sustaining local resources and the potential of that community to take action toward sustainability. In a rangeland context, this indicator can measure the contribution of local natural resources to individual satisfaction with multiple dimensions of community life. Conversely, community satisfaction level could be related to the likelihood of maintaining a viable mix of rangeland uses. The latter, once again, calls for additional research on links between social infrastructure and resource sustainability.

Indicator 41. Federal transfers by categories (individual, infrastructure, agriculture, etc.).

Federal transfer payments (e.g., food stamps, social security, Medicare/Medicaid, support for Women, Infants, and Children–WIC) are a relatively stable source of income to individuals and to local, especially county, governments during most economic conditions. This indicator is another aspect of economic resilience and the capacity to endure changes in economic conditions. The presence of such transfers could help counteract some of the adverse effects of poverty and income inequality.

Indicator 42. Presence and tenure of natural resource non-governmental organizations at the local level.

The presence of private sector non-governmental organizations (NGOs) is considered to be an indicator of professional administrative capacity for conceiving, implementing, and managing community projects relating to rangeland sustainability or restoration that otherwise would be unsupported by government agencies. It is also an indicator of how strongly such groups feel about the importance of natural resources in an area.

Indicator 43. Sources of income and level of dependence on livestock production for household income.

This indicator measures the degree of dependence of ranch families on livestock production for household income. Surveys have shown few ranchers rely totally on the ranch for household income (Gentner and Tanaka 2002; Coppock and Birkenfeld 1999). Higher dependence on the ranch for income may relate to the level of grazing during drought and the ability (or inclination) to follow sustainable grazing practices that might affect ecological sustainability, analogous to the Brazilian example described by Vosti (1993). A testable hypothesis might be: As income dependence on the ranch increases, ecological sustainability may be negatively affected. Alternatively, as non-farm income increases, ranch and rangeland sustainability might be positively affected. Data on sources of income for agricultural households are discussed by Brooks and Reimund (1989), Oliveira (1990), Hoppe et al. (1997, 2001), and USDA Economic Research Service (not dated).

Indicator 44. Employment diversity.

An economic diversity index can be developed to describe the industries and sectors present in an economy. If economic diversity is defined as “a large number of different types of industries being present in an area” or “the extent to which the economic activity of a region is distributed among a number of industrial sectors,” a summary statistic can be used to describe the diversity of an area and compare it to other areas. Measures such as location quotients compare local areas’ proportional employment in industries to those of a larger region. The Shannon-Weaver Diversity Index measures diversity of employment, considering both numbers of industries present and the distribution of employment across them, against a uniform distribution where employment is equi-proportional across all industries (Shannon and Weaver 1949; Attaran 1986). We hypothesize that economic diversity is related to economic resilience and the ability of an economy to respond and adapt to changes in conditions. Actual measures need to be calculated to provide full and consistent coverage, but necessary data are available at the county level. Data sources include the U.S. Economic Census (U.S. Census Bureau 1997, and other years) and the Bureau of Economic Analysis in the Department of Commerce.

Indicator 45. Agriculture (ranch/farm) structure.

This is a multi-component measure of direct production in agriculture. A farm or ranch is defined as having \$1,000 or more in gross agricultural sales. Other components of production include type of commodity produced, acres in production, dollar or volume levels of farm sales (a measure of scale), and the type of business organization (family, corporate, etc.). Farm structure is an indirect indicator of production capacity for food and fiber. It has become a data point to assess whether or not production can be sustained. There is not broad agreement on how the data might be interpreted, but there is agreement that these data are one basis for assessment (USDA National Agricultural Statistics Service 1992, 1997; USDA Economic Research Service, not dated).

Indicator 46. Years of education.

This indicator measures the years of formal education of the population of rangeland-dependent communities. It is an important measure of the human (and to a lesser extent social) capital available for sustaining a social group. Moreover, communities whose populations have higher levels of education may tend to have increased ability to recognize and respond to problems on local rangelands. Finally, communities with more highly educated populations might be associated with an increased likelihood of developing and maintaining community characteristics, such

as cultural and arts infrastructures, which enhance a community's ability to attract and maintain a diverse and sustainable population and economy. Data are collected both by census enumeration and through the Current Population Survey. A person is asked to indicate the number of years of education completed ranging from no formal education to years in graduate education.

Community Level Explanatory Indicators That Might Be Relevant to Sustainability

The following indicators describe local human conditions in ways that are hypothesized to be linked to rangeland use and sustainability. They also attempt to capture some of the underlying beliefs and attitudes in local areas that guide the ways in which people relate to and interact with natural resources in general, and rangeland in particular. Like most indicators, their primary utility may come from monitoring trends, rather than from values measured at any one time. Establishing some of the specific links between the indicators and rangeland sustainability is a subject for continued research.

Indicator 47. Value produced by agriculture and recreation industries as percents of total economic output.

Agriculture- and recreation-based industries appear to be two of the primary sector groups of the economy related to rangelands and rangeland sustainability. While neither occurs exclusively on rangelands, tracking what happens to them in rangeland-dominated counties should indicate the pressures being placed on rangelands. As population grows and economies change, we expect there to be a differential effect on rangelands. Of course, the values that comprise this indicator will only reflect production that flows through the economy. Nonmarket values that accrue to people from such things as recreation (beyond that captured in markets) and ecosystem services provided by rangelands will be missed by this indicator. Such values should not be ignored, however. They might become the bases for additional indicators or components of indicators over time.

Indicator 48. Employment, unemployment, underemployed, and discouraged workers by industrial sector.

Data on these variables provide information on the vitality of the local economy. High numbers in the unemployed, underemployed, and discouraged worker categories could indicate an economy in trouble and a community under stress. Such high numbers occurring in rangeland-related industries (e.g., livestock production, recreation, tourism) would provide an indication of pressures on rangeland-dependent livelihoods and lifestyles.

Indicator 49. Land tenure, land use, and ownership patterns by land size classes.

This indicator measures changes in ownership, ownership stability, and how the land is being used (e.g., ranging from public to private ownership, production agriculture to residential lots). It will measure how quickly rangelands are turning over (i.e., converting from one owner to another or from one use to another). It is important to sustainability because conversion of open rangeland to housing developments, for example, have an effect on many aspects of rangelands (e.g., loss of open space, habitat fragmentation, noxious weeds) as well as diminishing future options for the land. It is also important to know what the land use is changing to as turnover occurs.

Indicator 50. Population pyramids and population change.

Population pyramids are commonly used to describe a population's basic structure. They require data on gender and age. Data are organized into 5-year age cohorts; male and female. Each population pyramid provides a snapshot of the distribution of age groups and gender. For example, the baby boom cohorts born between 1945 and 1960 bulge out as they move through an otherwise relatively rectangular population structure.

This measure provides evidence of community sustainability by indicating key characteristics of social organization as they relate to providing social and economic services within a community. A population pyramid that varies little from the youngest to the oldest cohorts is considered to be sustainable. Widely different proportions of population in general age classes indicate differing needs over time with respect to social and economic infrastructures that may be more or less likely to be derived from rangeland activities. Bulges in the population pyramid indicate changing relative needs over time as the bulge moves through age classes. For example, a population with a structural bulge in older age groups has a different relative need for "senior centers" versus elementary schools than does a population with a bulge in very young age groups. Expanding and contracting needs for social services puts more stress on community infrastructure than does a situation in which there are fairly constant relative demands for social services over time. Actual measures must be calculated to produce population pyramids that provide full and consistent coverage.

Indicator 51. Income differentials from migration.

This indicator measures the differential between household income of existing residents in an area and that of in-migrants to the area. It addresses whether the people moving in are wealthier (or less wealthy) than those already there. Retirees or the wealthy may not rely on local natural resources for livelihoods in the same fashion as long-time residents or lower income in-migrants. Moreover, disparities in income are one indication of a lack of community cohesion that can be a barrier to local action on behalf of rangeland protection or sustainable management. This indicator could be expanded to compare out-migrants, remaining residents, and in-migrants. The same dataset could provide numbers of in- and out-migrants to an area, contributing to an assessment of trends in population increase or decrease.

Indicator 52. Length of residence.

This indicator measures individuals' longevity of residence in a particular community and relates to social cohesion and integration, as well as a willingness to interact with others for a common good. It is also a measure of community stability. A large proportion of new residents could point toward social dysfunction or low community cohesion that might have implications for rangeland sustainability.

Data on this variable have not been consistent over time in the U.S. Census of Population and Housing. The most recent censuses have focused on where people lived five years previous (same location as current residence, different location in the same county, different county in the same state, different state) as opposed to asking people how long they have lived in their current community, county, state. That might or might not decrease the usefulness of those data.

Indicator 53. Income by work location versus residence.

This indicator is an indirect measure of income generated within workers' areas of residence versus that from outside the area of residence. It indicates whether the residence community

provides both economic and social benefits to the income earner. For rangeland communities, it indicates the extent to which rangelands provide the desirable rural setting where people want to live, but without the employment opportunities they require.

Indicator 54. Public beliefs, attitudes, and behavioral intentions toward natural resources.

Public perceptions, intentions, and behaviors influence cultural, legal, and public policy decisions toward the management, consumption, and preservation of natural resources (Brunson and Steel 1994, 1996; Shields et al. 2002). In order for rangeland management decisions to be socially sustainable (especially on public lands), they must achieve and retain some minimum threshold of acceptability with citizens. Moreover, information about people's preferences and behavioral intentions can help in defining appropriate benchmarks for other indicators. This indicator would provide for regular measurement of preferences, attitudes, and intentions with respect to rangelands (and potentially other natural resource-based lands such as forests). Social science research indicates that a person's behaviors in political and planning arenas are influenced by his/her beliefs, attitudes, and behavioral intentions (Brunson and Steel 1996). Other indicators provide for measurement of behaviors (e.g., recreation uses, property sales, participation in restoration activities), but there are none that focus on the perceptual factors that underlie and guide those behaviors. Because there are no consistently available inventories of public preferences or values concerning natural resources and natural resource uses, data on public perceptions are often not diffused to the larger public or to the full spectrum of natural resource managers. These data would be applicable to all natural resources.

Conclusion

The development of indicators for the "Social and Economic Indicators of Rangeland Sustainability" criterion focused on three component areas. First, our focus was on products derived directly from rangeland ecosystems that are used by people and communities. Second, we focused on the communities themselves and how they react to what is happening in the larger ecosystem. Third, we tried to consider whether what is happening in the community is having an impact on the rangeland ecosystem. This latter effort is particularly troublesome because the links between social and economic indicators and rangeland sustainability are unknown in any rigorous sense. Data can be collected that describe whether local populations are growing and otherwise changing, as well as whether social and economic infrastructures are changing. Whether and how these factors of social and economic sustainability affect the ecological sustainability of rangelands remains unknown. Research is needed to rigorously identify and document such links.

Each set of indicators centers on one of these three ways of viewing the interactions among ecological, social, and economic systems. For this approach to be specifically useful for rangeland sustainability (as opposed to more broadly defined natural resource sustainability), we believe that the data must be sorted and analyzed by "rangeland counties," or those with some base level of dependence on rangeland and rangeland activities. While this definition needs to be developed, refined, and tested, we believe it is the only way to look at social and economic data in a useful way for rangeland sustainability specifically.

Much of the basic data needed to assess this criterion are currently available (Appendix 5-A). In many cases, those basic data will need to be organized and combined to calculate specific indicator variables. The weakest data are for the first grouping, "National Economic Benefits." Only

two of the 10 indicators have good, existing data while two others have partial data. This is in contrast to the “Community Well-Being” and “County-Level Explanatory Indicators” groupings where only two indicators in each group do not have methods and existing data. Taken as a whole, the set of indicators should provide information that can be used to assess the social and economic benefits derived from the nation’s rangelands. The issue still remains whether data can be disaggregated to a level that is relevant to the management of rangeland and to rangeland-dependent community sustainability.

Admittedly, these social and economic indicators are rather like a laundry list. Social and economic indicators of resource and resource use sustainability, in general, are at an earlier stage of development than ecological indicators just because people have not given them as much thought. With additional research and hypothesis testing, in the context of the conceptual framework laid out by Fox et al. (2009) and further developed by ongoing research, this list can be reduced to a more manageable list of indicators for which relevance to rangeland sustainability can be empirically demonstrated.

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Appendix 5-A. Data availability for Sustainable Rangelands Roundtable criteria and indicators.

No.	Indicator Category/Title	Geographic variation	Scale	Data Status (See Appendix 1-E)
27	The value of forage harvested from rangeland by livestock	Private lease rates, grazing costs (fee and non-fee costs), etc., are highly variable by geographic areas.	Mostly state-level; varies through time and space	A
28	Value of non-livestock products from rangeland	Currently unknown; specific products of interest vary geographically due to supply and demand.	Should vary through time and space	Will vary by product – must be clearly defined
29	Number of visitor days by activity and recreational land class	Generally unknown; specific locations near population centers see higher demand	Relevant at more local scales; will vary through time and space	C
30	Reported threats to quality of recreation experiences	No variation in reports; specific locations near population centers see higher incidence	Various; will vary through time and space if measures are consistent	B
31	Value of investment in rangeland, rangeland improvements, and recreation/tourism infrastructure	Demand differs by region	If tracked correctly, could be aggregated to any scale	D
32	Rate of return on investment for range livestock enterprises	Likely to be sensitive to regional variation	Useful at ranch, county, regional levels over time	D
33	Number and value of conservation easements purchased	Likely to be sensitive to regional variation	Parcel; could be aggregated to any level, most likely county	B
34	Expenditures (monetary and in-kind) for restoration activities	Likely to be sensitive to regional variation	Local; could be aggregated to any level, most likely county	C or D
35	The threat or pressure on the integrity of cultural and spiritual resource values	Meaningful at levels of individual jurisdictions, regions, nation	Can be aggregated to any level across time if measured consistently	D
36	Poverty rate – general	Regional variation, often related to minority populations	Easily aggregated over time and space	A
37	Poverty rate – children	Regional variation, often related to minority populations	Easily aggregated over time and space	A
38	Income inequality	Regional variation	Distribution is sensitive to scale	A
39	Index of social structure quality	Regional variation	Sensitive to temporal and spatial scales	B
40	Community satisfaction	Survey design can be used to capture variation	Relevant to temporal and spatial scales if gathered consistently	A

No.	Indicator Category/Title	Geographic variation	Scale	Data Status (See Appendix 1-E)
41	Federal transfers by categories (individual, infrastructure, agriculture, etc.)	Can vary by region	Local, county; can be aggregated	A
42	Presence and tenure of natural resource non-governmental organizations at the local level	Unknown	Unknown	C
43	Sources of income and level of dependence on livestock production for household income	Likely to vary based on data used	Unknown; likely to be meaningful based on measures used	Depends. Either B or D
44	Employment diversity	Should vary by region	More useful at local scales; can be used at county level	A
45	Agriculture (ranch/farm) structure	Should vary by region and locality	Sensitive over space and time; subject to changes in definition and needs to be adjusted for inflation	A
46	Years of education	Varies little by region; related to urbanization	Sensitive over space and time; easily aggregated	A
47	Value produced by agriculture and recreation industries as percents of total economic output	Should vary by region	Sensitive over space and time	A
48	Employment, unemployment, underemployed, and discouraged workers by industrial sector	Should vary by region	Local and county; sensitive over space and time; can be aggregated	A
49	Land tenure, land use, and ownership patterns by land size classes	Local, regional, national	Sensitive over space and time	D
50	Population pyramids and population change	Sensitive to location	Sensitive over space and time	A
51	Income differentials from migration	Sensitive to regions	Sensitive over space and time	A
52	Length of residence (native, immigrant more than 5 yrs, less than 5 yrs)	Sensitive to regions	Sensitive over space and time	A
53	Income by work location versus residence	Sensitive to regions	Sensitive over space and time; localized	A
54	Public beliefs, attitudes, and behavioral intentions toward natural resources	Sampling issue; expensive locally	Sensitive over space and time based on sampling frame	C or D